Mast-Mounted EXTRA-2 144 MHz Contest Preamplifier

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The EXTRA-2 144MHz preamp [1, 2] has lived up to expectations in practice, though there is need for the possible placing of the preamp in the feed point of the antenna, while containing the high frequency relays, as well. It would be an elegant solution if two professional coaxial relays were used for switching, but thus the preamp would be unaffordable. Now I'm presenting a solution that provides good isolation with cheap relays, and can be used with hundreds of Watts, as well.

I chose an RX114012C Schrack relay from the cheap ones. Its extremely short pins ensure excellent SWR at 144 MHz and its contacts of 12 A can switch even 1 kW power at 50 Ω. The only problem is that the big surfaces of the contacts result in very little isolation. This problem can be solved by connecting the high current relay with a microwave relay in series, at both input and output. In the TX period the applied high frequency relays switch both the input and output of the FET to GND, thus protecting the FET from the power of some Watts passing through the high current card relays. In the case of 1 KW TX power this saturated power could reach even 7-8 W without microwave relays, which could cause the breakdown of the FET.

The circuit diagram of the preamp can be seen in **Figure 1**. The circuit diagram of the surroundings of the FET is the same as the one of the original EXTRA-2 REV 6 version [2]. In favor of higher protection BAS70-04 processing diodes have been changed to microwave PIN diodes at the input and output, as well. This solution together with the relay composition presented above ensures the best protection for the FET. The DC power supply line is equipped with reverse polarity and overload diodes, and this latter can protect the preamp from close but not direct thunderbolts.

The preamp has been built on a 1,5 mm thick FR-4 type PCB. The connection between the two power relays has not been designed on the PCB, because it can easily burn through if applying "Legal Limit" power. To avoid this, semi-rigid cable of .141 has been used for the connection between the two relays.

The upgraded and modified preamp has been built in a waterproof and sealed cast aluminum box (Hammond 1550Z108). The connectors are also sealed, so the complete preamp can be mounted on a mast. The preamp includes a VOX circuit, but using a PTT control is more preferable. The DC power and the PTT line can be connected to the preamp through a 3-pin DIN connector. At this version DC cannot be fed through coaxial cable!

The layout of the Mast-Mounted Preamplifier PCB can be seen in **Figure 2**. **Figure 3** shows a photo of the ready PCB. The semi-rigid connection between the two power relays can be observed in **Figure 4**. Photos of the boxed preamplifier can be found in **Figure 5, Figure 6** and **Figure 7**. The parameters of the preamp are the same as the ones presented in [2]. **Figure 8** shows the through SWR of the preamp in TX mode, closed with a good quality dummy load.

The preamp can be used directly with all 50/100 W VHF radios that switch GND to PTT line in TX period. If applying a medium power PA, a sequencer circuit is essential to be used to avoid breakdowns.

Literature

[1] Dipl. Ing. Gyula Nagy, HA8ET: EXTRA-2 144 MHz Contest Preamplifier. DUBUS 4/2010 p.78
[2] Gyula Nagy, HA8ET: EXTRA-2 144 MHz Contest Preamplifier (REV6). Dubus 4/2011 p. 70

Technical data:

Frequency range:.....144-146 MHz (-1 dB)
Input/Output impedance: 50 Ω
Gain:..... 15 - 21 dB (adjustable)
Noise Figure.....<0,6 dB (typ 0,5)
S11:..... -9 dB @ 144MHz
S22:.....-23dB
1 dB / 3dB Bandwidth:....2,5 / 4,5 MHz
Max. Power with PTT:....750 W (Legal Limit)
IP3.....>22 dBm
Broadcast rejection:.....>63 dB @100 MHz
Rejection @ 432 MHz:...>50 dB
Supply voltage:..... +12...15V/230mA
Connectors:..... N females
Dimensions (Box):..... 125 x 81 x 61 mm
+40 dBm IP3 GaAs FET (ATF-53189)
Unconditionally stable, Moderate sensitivity to ESD

Part list

Teileliste

Reference	Value	Package	Distributor	Type	Manuf.
CT	3-10 pF	SMD	Farnell	TZB4Z100AB10R00	Murata
C1 (Microwave!)	15 pF	0805	Farnell	08052U150GAT2A	AVX
C2 (Microwave!)	22 pF	0805	Farnell	08052U270GAT2A	AVX
C3, C6, C18	100 pF COG	0805	Farnell	C0805C101J5GAC	KEMET
C4, C7, C8, 10, 17, 21, 23, 24, 25, 26, 27, 28	1nF X7R	0805	Farnell	08055C102KAT2A	AVX
C5, C9, C16, C19	100 nF X7R	0805	Farnell	08055C104JAT2A	AVX
C11, C15	150 pF COG	0805	Farnell	C0805C151J5GAC	KEMET
C12, C14	56 pF COG	0805	Farnell	C0805C560J5GAC	KEMET
C13	3,3 pF COG	0805	Farnell	ERB21B5C2E3R3B	Murata
C20	4,7 uF/50 V	7343	Farnell	T495X475K050AT	KEMET
C22	47uF/35V	0805	TME	SC1V476M6L006VR	Samwha
C	1.5 pF	-	-	20 mm .141 semirigid	Shuner
L1, L2	1000 nH	1008	TME	CW1008-1000	Ferrocore
L3, L4	24 nH	-	BEC	100072	TOKO
L5, L6	1uH	1206	Farnell	Ferrite	BOURNS
R1,	22	0805	Farnell		
R2	47	0805	Farnell		
R3	330	0805	Farnell		
R4	4,7	0805	Farnell		
R5	1	0805	Farnell		
R6, R8, R14	10	0805	Farnell		
R7, R9	100	0805	Farnell		
R10	1k	1206	Farnell		
R11	10k	0805	Farnell		
R12	1k	0805	Farnell		
R13	150	0805	Farnell		
D1, D2, D3, D4,	-	SOT-143	Digi-Key	SMP-1320-015 (PIN)	ALPHA
D5, D9, D10	-	0805	Farnell	1N4148 SMD	VISHAY
D6	-	DO214A	Farnell	FR1M	Semicron
D7	-	DO214AA	Farnell	P6SMB15CA	Semicron
D8	-	SOT-23	Farnell	BAS70-04	VISHAY
T1	-	SOT-89	Farnell	ATF-53189	Avago
T2	-	SOT-223	Farnell	PZTA14	NXP
T3	-	SOT-223	Farnell	BCP56-16	Infineon
IC1	-	D-PAK	Farnell	78M05CDT	STM
P1	500	SMD	Farnell	TS53YL501MR10	VISHAY
P2	100	SMD	Farnell	TS53YL101MR10	VISHAY
K1, K4	-	-	RS	RX114012C	Schrack
K2, K3	-	SMD	Farnell	IM06GR	TYCO
Box	-	-	Farnell	1550Z108	Hammond
RF Connectors	N Female	-	Farnell	11-19 TSS	Multicomp
Power supply conn.			Conrad	0107 05	Lumberg
PCB	-	-	HA8ET		HA8ET

Table 1

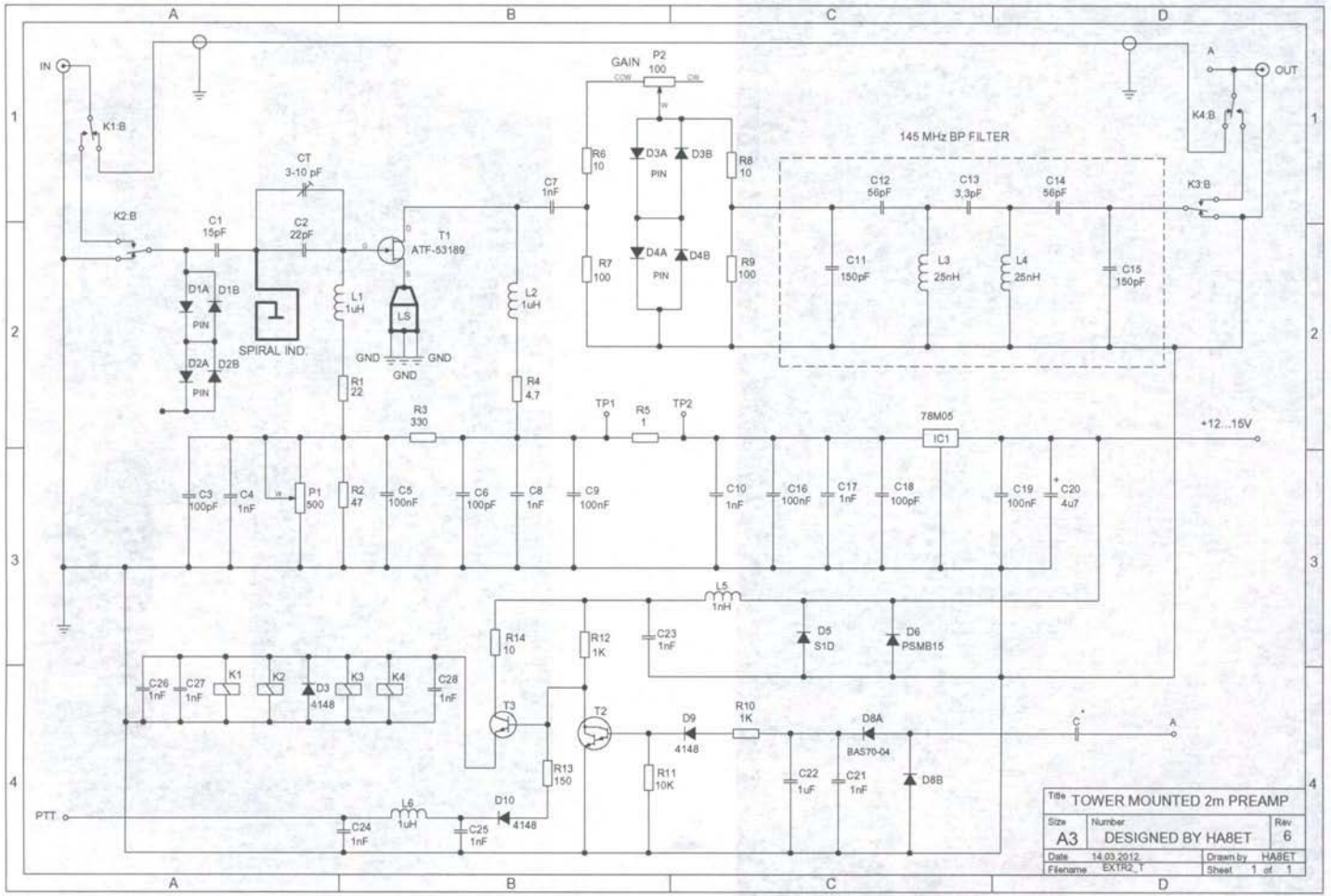

Fig. 1 – Circuit diagram

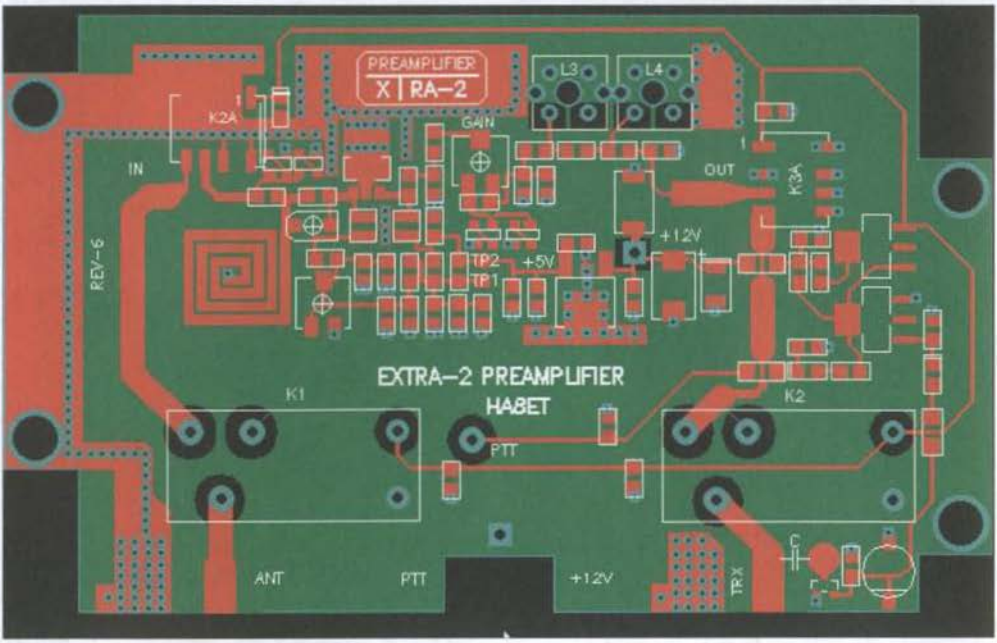
PREAMPLIFIER
X | RA-2
L3
L4
K2A
GAIN
IN
OUT
K3A
REV-6
+12V
TP2
+5V
TP1
EXTRA-2 PREAMPLIFIER
HA8ET
K1
K2
PTT
ANT
PTT
+12V
TRX

Fig. 2

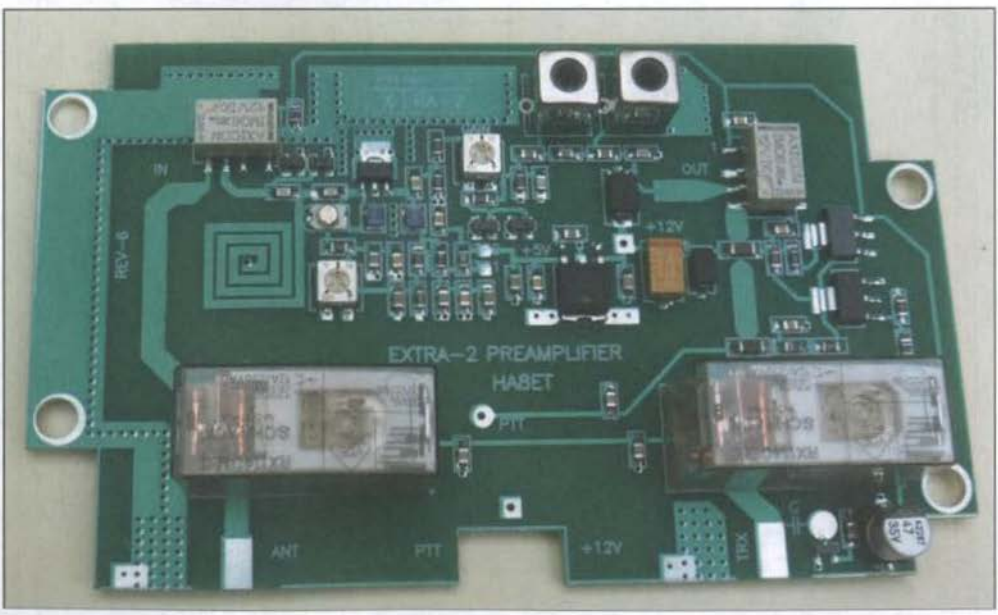
IN
OUT
REV-6
+12V
+5V
EXTRA-2 PREAMPLIFIER
HA8ET
PTT
ANT
PTT
+12V
TRX

Fig. 3

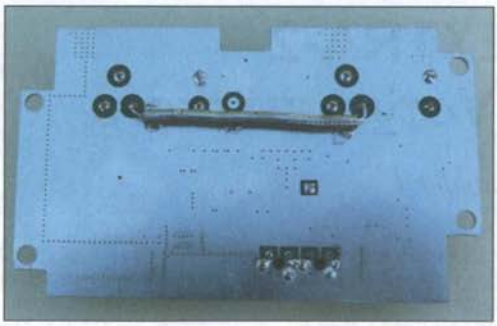

Fig. 4

Fig. 5

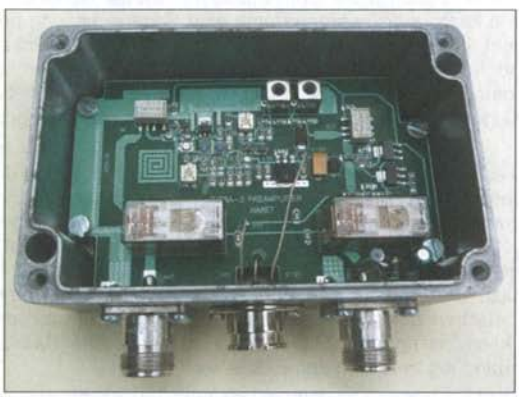

Fig. 6

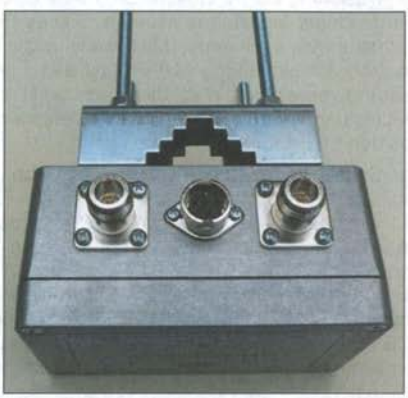

Fig. 7

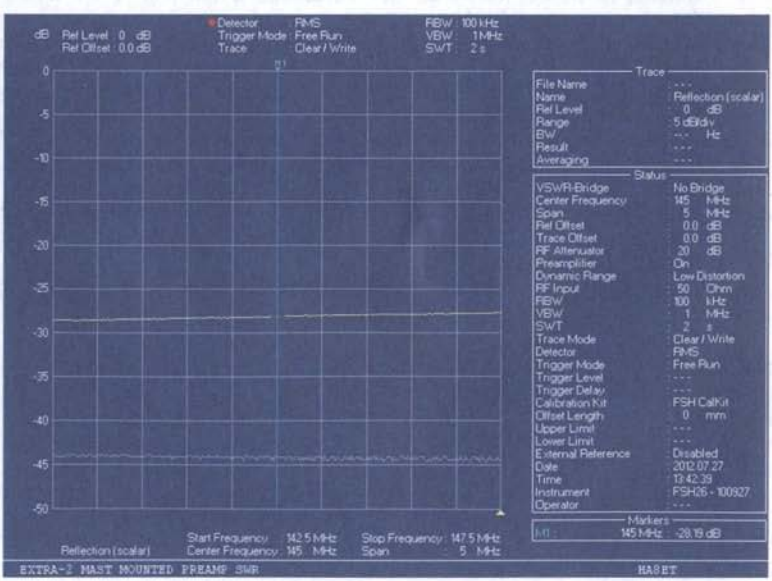

Fig. 8